# THE PRIVATE COSTS OF EXPOSURE TO PESTICIDES IN SRI LANKA: ESTIMATES FROM THREE VALUATION TECHNIQUES

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No. 277

July 2000

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July 2000

Discussion Paper No 277

ISSN 1033-4661

# THE PRIVATE COSTS OF EXPOSURE TO PESTICIDES IN SRI LANKA: ESTIMATES FROM THREE VALUATION TECHNIQUES[1]


## ABSTRACT

In this paper, estimates from three valuation techniques are used to show the private costs to farmers in Sri Lanka from exposure to pesticides during handling and spraying. The costs are shown to be large both to the farmers as well as to the country. These costs become all the more important when farmers' incomes vary a great deal due to adverse weather conditions, crop price fluctuations, pests and disease attacks, theft and damage caused by wild animals. All these costs while affecting the welfare of farmers, as well as their families, reflect the extent and severity of exposure to pesticides affecting those around, agricultural land, other production processes, wildlife and the environment in general. The study results could be generalized to other developing countries where farmers' exposure to pesticides is a common occurrence.


## 1. INTRODUCTION

Farmers handling and spraying pesticides on their farms suffer from numerous 'pesticide exposure' related illnesses, as well as precautionary costs. In this paper, three commonly used valuation techniques are used to determine the private costs to farmers spraying pesticides on their farms in Sri Lanka. Only private costs are considered because government hospital treatment is provided free of charge. The three valuation techniques used are the cost of illness (COI), avertive behaviour and the contingent valuation (CV) approaches.

Taking into consideration the costs of exposure to pesticides is useful for many reasons. Costs reveal the extent and severity of 'pesticide exposure' related illnesses to individuals, and society in general. Such a study gives an indication of the costs to government hospitals. In terms of foregone earnings, such measures not only reveal the loss of income to the affected individuals, but also show how much the family and the production processes can be affected. Furthermore, the estimation of costs reveal the probable benefits of minimizing or even avoiding such illnesses, especially important in the context of pollution control. By comparing the costs, both direct (e.g. medical expenditures) and indirect (e.g. foregone


[1] This study is part of my PhD thesis undertaken at the University of St Andrews, U.K. I wish to thank Professors Felix Fitzroy and Nick Hanley for helpful comments made during this time. I also with to thank Dr John Asafu-Adjaye for his comments. However, all remaining errors are mine.

earnings) and benefits of pesticide use, it is possible to show the welfare gains of a reduction in pesticide use. Estimating the precautionary costs, too, is useful for many reasons. Precautionary costs can determine whether farmers take adequate precautions during handling and spraying of pesticides, which is highly correlated with ill health resulting from exposure to pesticides (Wilson, 1998). The amount of money spent on avertive behaviour is an investment, not only to reduce short-term ill health, but also to reduce long-term illnesses and deterioration of human capital due to exposure to pesticides. The cost estimates presented in this paper are valid not only for Sri Lanka, but for all developing countries where exposure to pesticides by farmers is a common occurrence.

Section 2 of this paper gives a brief introduction to the problem of pesticide pollution in Sri Lanka and Section 3 examines the three valuation approaches used in the paper. Section 4 discusses the application of the three approaches to measure the costs of pesticide pollution and Section 5 presents and discusses the private cost estimates obtained using the three approaches. Section 6 provides cost scenarios for the entire country. The last section summarizes the conclusions of the paper.

## 2. THE PRIVATE COSTS OF EXPOSURE TO PESTICIDES IN SRI LANKA

Exposure to pesticides by farmers during handling and spraying result in adverse health effects. This is a common occurrence, not only in Sri Lanka but in all developing countries where pesticide spraying is carried out manually using hand sprayers. Statistics in Sri Lanka show that on average 14,500 individuals were admitted to government hospitals and around 1,450 individuals a year died from pesticide poisoning during the period 1986-1996 (National Poisons Centre, Sri Lanka, 1997). However, not all hospital admissions and deaths were due to occupational poisoning (i.e. due to handling and spraying on the farms) but include cases of self ingestion (suicides), accidental ingestion and homicides as well[2]. Apart from these hospital data, various medical field studies carried out on agricultural workers in Sri Lanka have confirmed high levels of ill health from exposure to pesticides among users ranging from dizzy feeling, headaches, nausea, diarrhoea, muscle twitching, rashes and cramps (Jeyaratnam 1982; Dharmawardena, 1994; Sivayoganathan et al., 1995; Hoek et al., 1997). Other field studies carried out, not only in Sri Lanka, but in other countries, too, confirm that

[2] No dis-aggregated data are available from the National Poisons Centre, Sri Lanka.

many ill effects take place during or soon after the application of pesticides in agriculture [Jeyaratnam et al., (1987, p.523); Rola and Pingali (1993, ch. 6); Lum et al., (1993); Kishi et al., (1995); Antle et al., 1998)]. These are short-term symptoms recorded during or soon after spraying pesticides. There are many short-term illnesses that arise on non-spraying days as well. Numerous studies in the United States have also documented long-term illnesses arising from exposure to pesticides [e.g Hoar (1986); Neilson and Lee (1987); Blair and Zahm (1993); Collins et al., (1993)].

As a result of ill health resulting from exposure to pesticides, farmers incur numerous tangible and intangible costs. In addition, farmers incur avertive costs due to preventive measures taken to reduce or altogether avoid exposure to pesticides. The field study which was carried out in the summer of 1996, the results of which are reported in this paper, revealed that 96% of the respondents had suffered some form of after-effect on a typical pesticide spraying day (excluding effects on non-spraying days or long-term effects) during the past year, but not necessarily leading to hospitalization or taking treatment from a physician, but however, incurring costs such as those due to self-treatment, loss of working days, loss of efficiency at work and loss of leisure time.

Table 1 shows the extent of costs arising from 'pesticide exposure' related illnesses and the costs of precautionary measures taken. The table shows that on a typical spraying day or soon afterwards (usually within four hours), 20% of the farmers interviewed had been admitted to hospital and incurred costs, 30% had taken treatment from a doctor and incurred costs and another 64%, although they were not hospitalized or did not require treatment from a physician, but nevertheless took home-made self-treatment and incurred other private costs. Furthermore, 42% of the respondents incurred illness-related costs on non-spraying days and 35% incurred costs due to long-term illnesses resulting from exposure to pesticides.

As Table 1 shows, farmers also incur precautionary costs. Therefore, it is necessary to estimate these costs to show how large and significant these costs are to farmers.

*Table 1* **Number of Respondents Incurring Costs due to Exposure to Pesticides in the Study Area**

| | Beligamuwa | | Ambana | | Kandalama | | Yatawatte | | Polonnaruwa | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Respondents | 42 | | 31 | | 46 | | 53 | | 31 | | 203 | |
| | No | % | No | % | No | % | No | % | No | % | No | % |
| **Medical And Other Costs** | | | | | | | | | | | | |
| A | 13 | 30 | 06 | 19 | 08 | 17 | 08 | 15 | 06 | 19 | 41 | 20 |
| B | 09 | 21 | 04 | 13 | 23 | 50 | 22 | 41 | 4 | 13 | 62 | 30 |
| C | 33 | 78 | 30 | 97 | 20 | 43 | 25 | 47 | 28 | 90 | 136 | 64 |
| NSD | 21 | 50 | 14 | 45 | 34 | 73 | 14 | 26 | 04 | 13 | 87 | 42 |
| LTC | 09 | 21 | 07 | 22 | 23 | 50 | 25 | 47 | 07 | 23 | 71 | 35 |
| **Defensive Costs** | | | | | | | | | | | | |
| PC | 20 | 48 | 31 | 97 | 32 | 69 | 25 | 47 | 16 | 51 | 123 | 61 |
| OC | 04 | 10 | 09 | 29 | 21 | 46 | 26 | 49 | 03 | 10 | 66 | 32 |
| All | 22 | 52 | 31 | 100 | 32 | 69 | 40 | 75 | 17 | 55 | 142 | 70 |
| E P | 42 | 100 | 31 | 100 | 46 | 100 | 49 | 92 | 27 | 87 | 195 | 96 |

Source: Survey data

Note: The costs of different categories of ill health experienced by a farmer are not mutually exclusive.

**A:** Respondents admitted to hospital and incurring private costs (includes all costs associated with pesticide pollution).

**B:** Respondents consulting a doctor and incurring private costs (includes all costs associated with pesticide pollution).

**C:** Respondents not admitted to hospital or consulting a doctor, but seeking some form of treatment and incurring private costs (includes all costs associated with pesticide pollution).

**NSD:** All private costs incurred on non-spraying days due to exposure to pesticides (includes costs of medicine, consultation and other costs).

**LTC:** All long-term private costs incurred due to direct exposure to pesticides (includes costs of medicine, consultation and other costs).

**PC:** Number of respondents incurring costs of some form of protective gear.

**OC:** Number of respondents incurring costs apart from costs of protective gear (for example, costs incurred on special storage and hiring labour).

**ALL:** Includes all respondents incurring costs on protective clothing and other defensive behaviour.

**EP:** Number of respondents suffering from acute illnesses described in the interview on a typical pesticide spraying day (excludes non-spaying days and long-term illnesses) and incurring costs. There were eight respondents in the sample (n = 203) who did not incur any costs.

## 3. THE THREE VALUATION TECHNIQUES

In order to estimate the costs arising from exposure to pesticides three valuation techniques, namely the COI, avertive behaviour and the CV approaches are used[3]. The former two approaches take into consideration only the tangible (both direct and indirect) costs while the latter approach captures the intangible costs such as pain, discomfort, stress and suffering as well. These are important costs to farmers exposed to pesticides during handling and spraying.

### 3.1 Cost of Illness Approach

The COI approach has been and is widely used in the estimation of costs arising from an illness or illnesses and has been particularly useful in showing the costs arising from pollution, food poisoning, water contamination and hence the benefits accruing from such control. Since the early 1950s a large number of studies estimating the costs of ill health and mortality have been based on the COI approach.

The COI approach is based on the notion that people are productive and, therefore, have value. Hence, it is implicitly assumed that productivity and value are associated with good health. Any illness is deemed to result in costs not only in medical expenditures, but also costs of foregone earnings and other expenditures related to the illness. Any action taken to improve health is interpreted as an investment both in terms of minimising or even avoiding medical expenditures, and incomes foregone and other calculable expenditures and of course contributing towards yielding a continuing return in the future. As Mushkin (1962, pp. 130 and 136) points out 'the yield for improvements in health is the labor product created plus any savings in health care expenditures due to any reduction in disease'. The COI approach is, therefore, based on the notion that an illness prevented means costs averted (see Wilson, 1998 for a discussion on the COI approach).

The costs considered by the COI approach are divided into two categories, namely direct and indirect. The direct costs refer to all the medical care and allied expenditures for diagnosis, treatment, other medical as well as non medical expenditures occasioned by illness [Hodgson

[3] Foster and Mourato (2000) have valued the multiple impacts of pesticide use in the U.K using a contingent ranking approach.

and Meiners (1982, p.432)]. The indirect costs are the foregone earnings [see Hodgson and Meiners (1982, p.434-435) for a detailed list of indirect costs]. It must be pointed out here that the COI approach provides only lower bound estimates of ill health.

### 3.2 Averting Behaviour Approach

Another indirect method of determining an affected individual's costs of exposure to pesticides is to use the cost of avertive behaviour approach. Of the three approaches discussed in this paper, the avertive behaviour approach has been the least employed technique to value costs arising from pollution related illnesses. However, this approach has been used in some environmental health related studies to value changes in respiratory symptoms arising from air pollution [Gerking and Stanley (1986); Bresnahan et al., (1997)], to avoid additional angina episodes [Chestnut et al., (1996)] and to bring about a reduction in the incidence of waterborne diseases [Harrington et al., (1989); Abdalla et al., (1992)].

The avertive behaviour approach is based on the notion that any avertive expenditure incurred (including time) infers an individual's cost for the subject in question. This approach takes into consideration the amount of expenditure an individual has incurred in taking precautionary measures to reduce or even avoid pollution effects. The value of a reduction in ill health, for example, can be inferred either from an averting activity that reduces exposure to pollution (such as wearing protective gear during pesticide handling and spraying) or that mitigate the strength or duration of symptoms, such as taking medication before being affected or in the case of pesticides even employing labour to spray these toxic chemicals[4]. As Cropper and Freeman (1991, p.182) point out when avertive activities are pursued to the point where the marginal cost equals the marginal value of reduced risk of an illness or death, then they can be used to estimate an individual's costs to reduce the risk of an illness or death. Otherwise, such an approach can yield lower bound values of ill health, costs of pollution or risks of accidents. However, it is correct to argue that most of the values obtained would be lower bounds. For example, Laughland et al., (1996) who from a validity test comparing CV to averting costs, arrive at a low avertive cost estimate which they state is 'consistent with the lower bound hypothesises' (p.109).

[4] Here, it should be mentioned that hiring labour to do some of the pesticide spraying is a precautionary activity and is categorized as a precautionary cost. On the other hand, if a respondent suffered from ill health due to exposure to pesticides and hired labour to work on the farms (including spraying pesticides) due to inability to work, then it is categorized as a cost of illness.

This approach, like the COI approach considers all direct and indirect costs. In the case of exposure to pesticides, all avertive costs, such as wearing protective gear, any employed labour and other related costs are considered. Time spent purchasing protective gear and maintenance are also taken into consideration. One major advantage of the avertive behaviour approach is that, this approach can be examined in conjunction with the COI and CV approaches with only some additional sections added to the questionnaire. This exercise can be used to test the validity of the CV responses.

### 3.3 Contingent Valuation Approach

The appeal of the CV approach is that, in principle, it can estimate the value of environmental goods or costs of environmental damage that are specific to environmental pollution or a specific disease category. This method has been recommended especially for the estimation of costs that are difficult to estimate such as non-use values (existence values) and intangible costs (pain, stress, discomfort and suffering) where there are no direct market transactions taking place to obtain and to estimate economic costs. This technique tries to cover such a void. Because of these attributes, the CV approach has become a unique technique which provides a conceptually correct and a more complete approach to estimate values and costs than any other technique that values non market goods such as the environment and total costs of ill health.

Although initially this technique was developed to measure the value of recreation and the environment it has been adopted by economists to measure the value of risk reductions, too, and in recent years many studies have been carried out by health economists to assess the value of health care and the cost of illnesses [e.g. see Easthaugh (1991); Johannesson et al., (1991); Johannesson (1992)]. Many CV studies have been conducted to determine the cost of symptoms (e.g. headaches, eye irritation, sinus congestion, wheezing and nausea) associated with environmental pollution. For example, some studies have been carried out to value the cost of ill health, both minor and acute, associated with air pollution by Loehman et al., (1979), Rowe and Chestnut (1985), Tolley et al., (1986), Dickie et al., (1987) and Alberini and Krupnick (1998).

The CV approach obtains the value to individuals of an environmental good, the costs of environmental damage or the cost of pollution through the use of carefully designed and

administered sample surveys. The main strength of this technique in the field of health economics is to consider intangible and invisible costs such as pain, stress, discomfort and suffering which the COI and the avertive behaviour approaches fail to capture.

## 4. DATA COLLECTED FROM A FIELD SURVEY IN SRI LANKA USING THE THREE APPROACHES

In this paper, data collected from a sample of 203 farmers surveyed in Sri Lanka during the summer of 1996 are used. During the field survey, five areas were sampled from the intermediate dry zones of Sri Lanka where intensive agriculture is widespread. The regions covered were Yatawatte, Kandalama, Beligamuwa, Ambana and Polonaruwa in the Central and North Central provinces of Sri Lanka, within a 75-100 mile radius. Only farmers who are regular pesticide users and cultivate land not less than half an acre and not more than three acres were selected, because according to a census carried out in 1982 by the Department of Census and Statistics, Sri Lanka, the average size of land cultivated in the country was 1.94 acres. The five regions selected specialize in growing various food crops. As a result, the level and intensity of pesticides used and the level of exposure to pesticides vary from region to region. Judgment sampling was employed to collect the necessary data for the study. Prior to the interviews, a pilot study was conducted to determine the viability of questions prepared to collect the necessary data. The questionnaire was modified, removing questions that proved difficult to administer. The questionnaire was designed to estimate the costs using the three valuation approaches.

The COI approach considered costs arising during spraying or soon after spraying or on non-spraying days (e.g. the day after) from acute short-term symptoms and from long-term effects. The severity of short-term illnesses experienced by farmers on spraying and non-spraying days were grouped into three categories, namely severe, moderate and mild.[5] In all of these three categories, farmers suffer private direct, indirect and intangible costs. The direct and indirect costs can be further subdivided into medical costs which include physician visits, private hospitalization, laboratory, emergency room visits and drug prescription costs. These are categorized as direct costs. Other direct costs include dietary expenses resulting from

[5] An illness is described as serious where the respondent is hospitalized, a moderate illness is where the respondent takes treatment from a physician but is not hospitalized and the mild case is where a respondent is neither hospitalized nor sought treatment, but takes home-made self-treatment and incurs other private costs.

illnesses, travel costs associated with medical treatment, hired labour due to inability to work, protect crops from pests and diseases, wild animals and theft. The indirect costs are working days or hours lost, loss of efficiency on farm, time spent travelling and seeking treatment and leisure time losses.

A major portion of the losses estimated using the COI approach are from imputed value of lost time rather than from out-of-pocket expenses. The out-of-pocket expenses are relatively small compared to the time costs because almost all affected farmers sought treatment from government hospitals. Thus, the valuation of time is critical. While the calculation of the loss of efficiency resulting from exposure to pesticides is subjective, such a cost addresses a real economic consequence of illnesses of this sort. The inclusion of leisure hours is also no doubt subjective, but it emphasizes the economic consequences of the illnesses. The inclusion of leisure hours is all the more important when it is considered that loss of leisure hours affects productivity. It must be mentioned that estimating the number of leisure hours lost as well as lost efficiency is a difficult task. Leisure hours were taken to be any time spent at home after work such as reading a newspaper, watching television, listening to the radio, pursuing a game or a hobby or time spent with the family. Sleeping hours are not included nor was the time spent attending to domestic chores. Loss of efficiency was defined as the lessening of one's productivity while working. The estimation of working days or hours lost and time spent travelling to hospital and seeking treatment is less troublesome to calculate. Once the lost time has been calculated, the conversion to monetary terms was straightforward. Following Becker (1965), lost working time, efficiency, leisure hours, time spent travelling to hospital were calculated at the prevailing hourly average wage rate in the areas for the interviewed farmers. The hourly wage rate was derived by dividing an average days' labour wage by the number of hours worked. The prevalent average cost of labour for a day in the study area was Rs 150 and the number of hours worked for this sum was 8 hours[6]. The average cost of labour was calculated by dividing the wage rate by the number of hours worked per day.

The avertive behaviour approach considered costs incurred by farmers to minimize ill health resulting from exposure to pesticides. It was found that 61 percent of the interviewed farmers

[6] The exchange rate prevailing during the study period (June-September, 1996) was 1US$ = 55 Rs (approximately).

had incurred some form of expenditure on protective gear and other defensive behaviour. The survey revealed that the farmers resorted to a wide variety of strategies to reduce the impact of exposure to pesticides. These include protective gear worn during pesticide handling and spraying, using safer sprayers (but more expensive) and hiring labour on certain days to spray the pesticides. However, these measures were often found to be insufficient and inadequate. Hence, the reason for the high level of exposure to pesticides and the resulting ill health. In order to calculate the costs of precautions taken, the prevailing market prices were used.

The CV question was designed to determine the costs of exposure to pesticides. Before the CV question was asked, a broad introduction about pesticide pollution in the country in general was given. The health hazards faced by small-scale farmers handling and spraying pesticides on a regular basis were explained by the interviewer. Farmers were already aware of the health hazards resulting from exposure to pesticides and the associated costs. However, in keeping with the NOAA (1993) guidelines, relevant information was provided to the farmers. Furthermore, information on the health status of the interviewee was obtained using the same list of illnesses used in the Siyayoganathan et al., (1995). Only illnesses diagnosed by physicians as arising from exposure to pesticides or those illnesses which farmers can strongly attribute to the use of pesticides were considered. By the time the interviewer got to the CV section of the questionnaire, the respondents were aware of the costs (both tangible and intangible) associated with exposure to pesticides. This was because the questions preceding the CV considered the tangible costs arising due to ill health and precautions taken. Because the farmers had already suffered costs and they knew what they were, it was clear that an open-ended format was more suitable for a study of this nature although dichotomous choice CV question format has gained popularity over the last 3 decades, especially after the influential NOAA panel (1993) report. One main reason not to adopt a close-ended question format was that, as Whittinton (1998) points out, if the amount the enumerator asks lacks credibility, the respondent is unlikely to answer the question on the basis of the amount suggested. Furthermore, the type of format depends on the nature of the study and conditions prevailing in developing countries. These considerations were taken into account in selecting an open-ended question format for this study. For a detailed discussion on the disadvantages of the dichotomous choice format and the advantages of the open-ended question format for this study, see Wilson (1998).

The respondents were informed that the CV question was aimed at measuring the cost of ill health from exposure to pesticides or in other words how much they were willing to pay to avoid exposure to pesticides if a programme was devised to prevent such illnesses. Respondents were informed of the economic sacrifice they would have to make to support such a prevention programme. The farmers were told that the money will have to come out of their income or some other income source. They were specifically told about the range of options available to avoid exposure to pesticides [e.g using safer but more expensive pesticides; adopting integrated pest management (IPM) strategies which, however, could cost more to adopt; and hiring labour to spray pesticides. The choice of the payment vehicle to undertake prevention programmes was also made as realistic as possible. Taxes were deliberately avoided because during the pre-testing of the questionnaire (pilot study), it was found that respondents disliked the idea of taxes and thought that this study was being conducted to compile a register for the implementation of taxes in the future. Therefore, because of such difficulties, higher prices/costs were preferred to taxes[7]. All the respondents in the study areas were provided with the same information, including the payment vehicles suggested. The socio-economic and costs of exposure to pesticides data gathered prior to the CV question enabled to test the validity and reliability of the CV exercise.

## 5. ESTIMATED COSTS OF EXPOSURE TO PESTICIDES USING THE THREE APPROACHES

Table 2 shows the costs arising from exposure to pesticides. The costs vary according to the three approaches. There are many reasons for this. While the COI and the avertive behaviour approach are capable of estimating only the tangible costs of exposure to pesticides, the CV technique captures the intangible costs as well. For a theoretical discussion why the CV estimates normally exceed COI and avertive behaviour estimates see Cropper and Freeman (1991) and Wilson (1999). Intangible costs arising from exposure to pesticides in the form of discomfort, pain, stress and suffering are frequent and considerable. These are important costs which are often ignored. Farmers exposed to pesticides often stated that these costs could exceed tangible costs. This was the main reason why the CV approach was used for this study, in addition to the other techniques used. It must also be pointed out that the CV

[7] For a CV study that uses the wording 'higher prices' to describe the payment, see Kenkel et al., (1994) and Ready et al., (1996).

approach includes the costs of both the COI and the avertive behaviour approaches. Furthermore, it was stated in Section 4 that the COI and avertive behaviour approaches could not capture some of the costs from exposure to pesticides due to difficulties in collecting such data.

***Table 2*** **Pesticide exposure related costs from three valuation techniques**

| Valuation Technique | Average Costs from Exposure to Pesticides Rs |
|---|---|
| [1] Cost of Illness Approach | 5,465.51 |
| [2] Avertive Behaviour Approach | 405.14 |
| [3] Contingent Valuation Approach | 11,471.18 |

Source: Survey data

As shown in Table 2, the costs incurred by farmers are considerable. The CV approach estimate shows that a farmer on average incurs a cost of more than two and a half months income from farming per year (the average monthly income is Rs 4,748.17) from 'pesticide exposure' related illnesses. The estimation from the COI approach shows that a farmer on average incurs costs which amount to more than a month's income from farming per year, while the avertive behaviour approach estimates the costs to be Rs 405 a year. The costs incurred on avertive behaviour are low by any standard, especially when dealing with dangerous chemicals such as pesticides. It is not surprising that ill health and mortality rates from exposure to pesticides are high among farmers in Sri Lanka. The low avertive costs also confirm the fact that despite the wear and tear of the protective gear, they are repeatedly used. Hence insufficient investment in protective gear and their poor quality (due to wear and tear) increase the incidence of exposure to pesticides and, therefore, is one of the chief causes for the high ill health prevalent among farmers in the country. However, this low figure, amounts to around 12% of a monthly income of a farmer. When these avertive behaviour and the out-of-pocket and time costs of illnesses are considered, they can be significant costs to farmers. These costs become all the more significant when farmers' incomes vary a great deal due to adverse weather conditions, crop price fluctuations, pests and disease attacks, theft and damage caused by wild animals. In addition, the price of purchased inputs such as pesticides and fertilizers and lack of proper marketing channels increase farmers' costs of production. All these costs while affecting the welfare of farmers and their families, also reflect the extent

and severity of exposure to pesticides affecting those around, agricultural land, affecting other production processes, wildlife and the environment in general. The costs to the country from exposure to pesticides alone run into millions of Sri Lankan rupees which can be avoided to a large extent if adequate safeguards are adopted during handling and spraying pesticides.

## 6. TOTAL LOSSES TO FARMERS IN THE COUNTRY FROM EXPOSURE TO PESTICIDES

The procedure used to estimate total costs from exposure to pesticides was straightforward. It was assumed that the sample of 203 respondents is representative of the farmers using pesticides in Sri Lanka. No one knows for certain (including the Department of Agriculture, Sri Lanka) how many farmers are currently using pesticides. According to 1978 employment survey of Sri Lanka, it is estimated that there are 472,435 agricultural workers in Sri Lanka[8]. However, these figures include plantation workers such as tea, rubber and coconut where the use of pesticides is minimal and that all of them are not employed to spray pesticides. It is the self-employed farmers (often on a small-scale) growing vegetable crops and rice who use pesticides on a regular basis. Since this survey, no island-wide census has been carried out due to the continuing civil war in the North and East of the country. Therefore, in order to provide estimates for the entire country, cost scenarios are provided for farmers incurring costs from exposure to pesticides. In this study it is assumed that at least a minimum of 50,000 farmers and a maximum of 300,000 of the 472,435 agricultural workers use pesticides on a regular basis and are exposed to pesticides. It is believed that the true figure lies in this range.

Table 3 shows the four scenarios for the three approaches. The estimates from the three approaches show that the cost of exposure to pesticides among farmers in Sri Lanka run into millions of Sri Lankan rupees each year. The estimates are, by any standard large, especially for a small developing country. The minimum total estimate from the COI approach shows that farmers in Sri Lanka lose around Rs 273 million (scenario A) in the form of out-of-pocket and time costs and the high cost scenario (scenario D) shows that farmers lose more than Rs 1,639 million. These costs are conservative estimates especially because only private costs were considered. The avertive behaviour approach estimates that farmers in Sri Lanka

[8] Jeyaratnam et al., (1982), too, use these survey data for their study.

spend more than Rs 20 million (scenario A) in the form of precautionary costs per year and the high cost scenario (scenario D) shows the figure at more than Rs 121 million. These estimates are by any standard conservative. This is because only some of the precautionary costs incurred by farmers were considered. Many precautionary costs have not been considered due to the non-availability of data as discussed in Section 4. The CV estimates show that costs are even larger. The lowest CV bid shows that costs of exposure to pesticides (or the value to farmers in Sri Lanka of avoiding exposure to pesticides) is more than Rs 573 million (scenario A) while the high cost scenario (scenario D) indicates that farmers incur a cost of more than Rs 3,441 million.

*Table 3* **Cost of 'Exposure to Pesticides' Scenarios in Sri Lanka (in Millions of Rupees)**

| Valuation Technique | Cost Scenarios A | B | C | D |
|---|---|---|---|---|
| [1] Cost of Illness Approach | 273 | 546 | 819 | 1,639 |
| [2] Avertive Behaviour Approach | 20.25 | 40.51 | 60.77 | 121.54 |
| [3] Contingent Valuation Approach | 573 | 1,147 | 1,720 | 3,441 |

*Source*: Survey data
*Note*: The average cost of illness costs are multiplied by the number of farmers who are assumed to be affected by exposure to pesticides. It is assumed that between 50,000 to 300,000 farmers are affected. Accordingly, the scenarios as follows: Scenario A =50,000 farmers. Scenario B = 100,000 farmers. Scenario C = 150,000 farmers. Scenario D = 300,000 farmers.

## 7. CONCLUSIONS

In this paper three valuation techniques were used to show the extent of private costs to farmers from exposure to pesticides during handling and spraying. By any standard these costs are considerable. The estimates from these approaches showed that costs relating to exposure to pesticides amounted to millions of Sri Lankan rupees each year. These costs become all the more important when farmers' incomes vary a great deal due to adverse weather conditions, crop price fluctuations, pests and disease attacks, theft and damage caused by wild animals.

The current high levels of exposure to pesticides not only affect human capital, but as the costs have demonstrated, may well be a factor in explaining poverty (low incomes) among farmers, despite adequate food being produced all year around. This is due to the high costs from both ill health and input use. The numerous health effects result in medical as well as time costs, both in the short and in the long-term. Wasting of human capital reduces the ability to work on farms. The precautions taken, though inadequate, also incur costs. Pesticide pollution also affects natural capital in the form of decimation of natural predators of pests, increase in the proliferation of pests (due to decimation of natural predators) thus affecting agricultural production and productivity. As a result larger quantities of chemical inputs (e.g. pesticides) have to be used in the production process (e.g. to combat the proliferation of pests). This not only increases the level of pollution on agricultural lands and affects farmers' health further, but also increases the costs of input use. Furthermore, pesticides affect other production processes such as fisheries (which some subsistence farmers engage in on a part time basis), thus depriving them of an additional source of income. Several other production externalities were noted during the field survey. Herbicides used on onion plots to destroy weeds when spread to neighbouring farms due to strong winds destroyed other crops which were not resistant to the herbicides used. The damage done was large since it affected the crop of an entire season. Therefore, in conclusion it could be said that the costs from pesticide pollution is not only considerable but has adverse effects on long-term human capital as well. This calls for urgent measures to remedy this situation. Otherwise, the costs to the farmers as well as to the country will not only increase but will remain a burden on society and continue to affect farmers' incomes and their families welfare.

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